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ABSTRACT

The study examined the relationship between perinatal stress and decreased right handedness and decreased left cerebral dominance for speech with 215 children born prematurely, followed from birth, and tested at age 5. Results indicated that neither hand preference nor hand performance correlated with degree of perinatal stress and that eye preference was associated with perinatal stress though crossed eye dominance was not. The dichotic listening measure showed an overall right ear advantage (the usual speech dominant ear) suggesting an increased degree of cerebral dominance for speech. (DB)

LATERALITY IN PREMATURELY-BORN CHILDREN[1]

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RESEARCH QUESTION: IS PERINATAL STRESS ASSOCIATED WITH DECREASED RIGHT HANDEDNESS AND WITH A DECREASED LEFT CEREBRAL DOMINANCE FOR SPEECH?

BACKGROUND ISSUES:

Perinatal stress has been reputed to be a causative agent in non righthandedness, whether as a strong determinant of left handedness (Bakan, 1971; Bakan, Dibbs & Read, 1973) or a factor only in "pathological" left handedness (Satz, 1972) Similarly, early left hemisphere damage leads to a likelihood of right hemisphere specialization for language (Orsini, Satz & Zemansky, 1985).

Previous studies

The problems with retrospective studies are well-known Two large-scale prospective studies on perinatal stress and handedness have been done. Both McManus (1981) and Spiegler and Yeni-Komshian (1982) found that none of the many perinatal factors available reliably differentiated handedness. Because of the nature of the data bases, both these studies used a rather limited definition of handedness (the writing hand) and neither examined cerebral dominance for speech. Also, the use of normative populations may have masked any effects attributable to the relatively small number of at-risk pregnancies.

Satz (1972) presents a model that accepts some but not all left handedness due to Perinatal Stress. He accounts for the increased incidence of left handedness among pathological populations (epileptics, autistic children, mentally retarded) as an artifact of the smaller number of left handers in the population. According to this model, some left handers received their lateral asymmetry as a result of Perinatal Stress but other left handers are healthy.

SUBJECTS: 215 children born prematurely, with a measured risk for oxygenation difficulties followed from birth and tested at age 5 years (see Table 1).

MEASURES:

(1) Instrument to assess perinatal stress: See Table 2 for details The mean Perinatal Stress score was approximately 9, with a standard deviation of 3. Consequently, the HI RISK group were those with a score of 12 or more (n = 57). The LOW RISK group had 158 children.

(2) Lateral Preference Performance Measure: Hand, foot, eye and ear preference as measured in behavoural tasks based on Coren, Porac and Duncan (1981).

(3) Child Edinburgh Handedness Inventory: A hand preference performance task based on the first 8 items of the Edinburgh Handedness Inventory (Oldfield, 1971)

(4) Dot-Filling-In Task: A hand performance asymmetry task based on Tapley & Bryden (1985).

(5) Dichotic Listening speech task: A dichotic listening task with trials consisting of a prime (tame, dame, came or game) followed by a dichotic pair, one of which repeated the prime in half the trials.

(6) Columbia Mental Maturity Scale: A nonverbal cognitive assessment tool designed to be culturally fair.

(7) WPPSI IQ: A standardized IQ test with verbal and performance components.

PROCEDURE: Each subject was tested individually in the home during two visits, one at age 5 years and the second 3 months later. The Columbia Scale and all the laterality measures were given on the second visit.

RESULTS:

(1) Hand preference did not correlate with degree of Perinatal Stress, nor did HIGH RISK and LOW RISK groups differ on any of the measures of hand, foot or ear preference. Facility with the NONDOMINANT hand was also similar across the high and low Perinatal Stress groups.

(2) Hand performance, as measured on the Dot-Filling-In task did not correlate significantly with Perinatal Stress. The HIGH RISK group did, however, show less absolute asymmetry ($p < 0.05$) and produced a lower total score (number of dots over both hands) ($p < 0.05$).

(3) Eye preference was associated with Perinatal Stress ($p < 0.01$), with high Perinatal Stress correlating with left eye preference (see Figure 1). Crossed-eye dominance, however, was not more prevalent among the high PS children (HIGH RISK: 36.6%; LOW RISK: 36.7%).

(4) The dichotic listening measure of cerebral dominance for speech (using the R-L/R+L metric) produced an overall right ear advantage (REA) ($p < 0.001$). There was a sex difference where girls showed less asymmetry than boys, but did not differ in total correct over both ears. Perinatal Stress correlated significantly ($r = 0.21$, $p < 0.005$) with dichotic listening asymmetry, where those high in Perinatal Stress have higher REAs than those with low Perinatal Stress. This is due to a sharp drop

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in the left ear scores (see Table 3).

In the LOW RISK group, left handers showed a decreased REA, whereas the handedness effect did not appear in the HIGH RISK group (see Table 4).

CONCLUSIONS

On handedness and perinatal stress

This sample of at-risk children should provide evidence to support links between perinatal stress and laterality indices if they exist. We did not confirm the link between left handedness and Perinatal Stress as suggested by some researchers. It may be that Satz's notion of pathological left handedness applies to those with extremely high perinatal stress or only to those with frank brain damage, but certainly not to a group of at-risk children most of whom develop within the normal range.

On cerebral dominance and perinatal stress

Cerebral specialization for speech does not seem to be shifted by Perinatal Stress to the right hemisphere, but rather the opposite is found -- a stronger right ear advantage. We do not think this is indicative of a general attentional shift to the right side or to the right ear because on the nonverbal ear-preference task and on the other lateral preference measures (based on Coren, Porac & Duncan, 1981), there were no effects of Perinatal Stress. One other attentional hypothesis is possible. It may be that the HIGH RISK children found the dichotic listening task so taxing that they adopted the strategy of attending to the speech-dominant ear only. If this were true then we might reasonably expect a lower performance in the right ear and a greater drop in the left ear. However, only the left ear drop was found. We conclude, then, that this group indeed has an increased degree of cerebral dominance for speech.

On eye preference and perinatal stress

The association between left eye preference and perinatal stress is puzzling. It is not due to an increase in crossed-eye dominance (the association of one hand preference with the opposite eye preference). It was not associated with lower intelligence levels. Paradoxically the opposite was found: Within each Perinatal Stress grouping, the degree of left eye preference was associated with increased intelligence! (See Figure 1.) We have no explanation for the eye preference effect in terms of cerebral mechanisms.

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TABLES

Table 1. Sample size (N) on which analysis based for each variable

Variable	N
Perinatal Stress Scale	215
Columbia Mental Maturity Scale	213
Dot-Filling-In Test	211
Dichotic Listening Test	201
Lateral Preference Performance Measure	215
Child Edinburgh Handedness Inventory	207
Female Subjects	108
Male Subjects	107

Table 2. The Perinatal Stress (PS) index is calculated from a weighted scoring of the following 27 questions.

Score 1:

(1) Drug used to stimulate labor
(2) Length of second stage of labor exceeds:
  i) for primapara 2 hours
  ii) for multiparas 1 hour
(3) Vaginal delivery
(4) Use of low or outlet forceps
(5) Meconium aspiration probable
(6) Persistent baseline tachycardia
(7) Suctioning and oxygen by mask required at birth
(8) 34 to 37 weeks gestation

Score 2:
(9) Precipitous delivery
(10) Use of mid-forceps
(11) Forceps rotation of fetus required
(12) Cord around neck
(13) Transport required
(14) Late or variable deceleration
(15) Prolonged bradycardia - more than 3 minutes
(16) Loss of beat to beat variability
(17) Apgar less than 3 and greater than 0 at 1 minute
(18) Apgar less than 6 at 5 minutes
(19) 29-33 weeks gestation
(20) Indicated caesarian section
(21) Infection probably present at birth
(22) Potential for hypoxia 1st 12 hours
(23) Breech delivery
(24) 2nd, 3rd or 4th in multiple birth

Score 3:

(25) Apgar 0 at 1 minute
(26) Intubation and positive pressure ventilation required
(27) Less than 29 weeks gestation

Table 3. Number of Boys and Girls with each Type of Listening Ear Advantage and the Average Score for Each Ear.

	Boys	Girls	Total
Left ear advantage	13	24	37
Right ear advantage	76	65	141
No ear difference	7	13	20
Left ear score	4.20	4.51	
Right ear score	6.65	5.80	
Total score	10.85	10.31	

Note
Chi-square for number of boys (LEA vs REA) = 4.16, d.f. = 1, $p < 0.001$
Chi-square for number of girls (LEA vs REA) = 1.89, d.f. = 1, $p < 0.001$
Chi-square for number of boys vs girls with a left vs right ear advantage = 4.13, d.f. = 1, $p < 0.05$

Table 4. Differences in dichotic listening asymmetry (R-L/R+L) across left and right handers in low and high Perinatal Stress groups.

	HANDEDNESS		
	LEFT	RIGHT	
LOW RISK	.01	.18	$p < 0.05$
HIGH RISK	.31	.30	n.s

Figure 1 The distribution of the eye preference scores on the Lateral Preference Performance measure (where positive values indicate a right eye preference) with respect to intelligence and Perinatal Stress (PS) The Columbia intelligence scale is divided into quartiles, Quartile 1 being the lowest scorers Perinatal Stress group 2 has a PS score greater than 1 standard deviation above the mean of the PS values.